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(54) **Starch extraction**

(57) A method of recovering starch from Cassava and like roots comprises:

(i) pulverising whole unskinned roots;

(ii) pressing pulverised roots to separate fibres from naturally present juice and starch;

(iii) separating the starch from the juice; and

(iv) returning at least part of starch free juice to the roots during pulverisation;

the steps (i) to (iv) being performed in the absence of liquid other than said naturally present juice.

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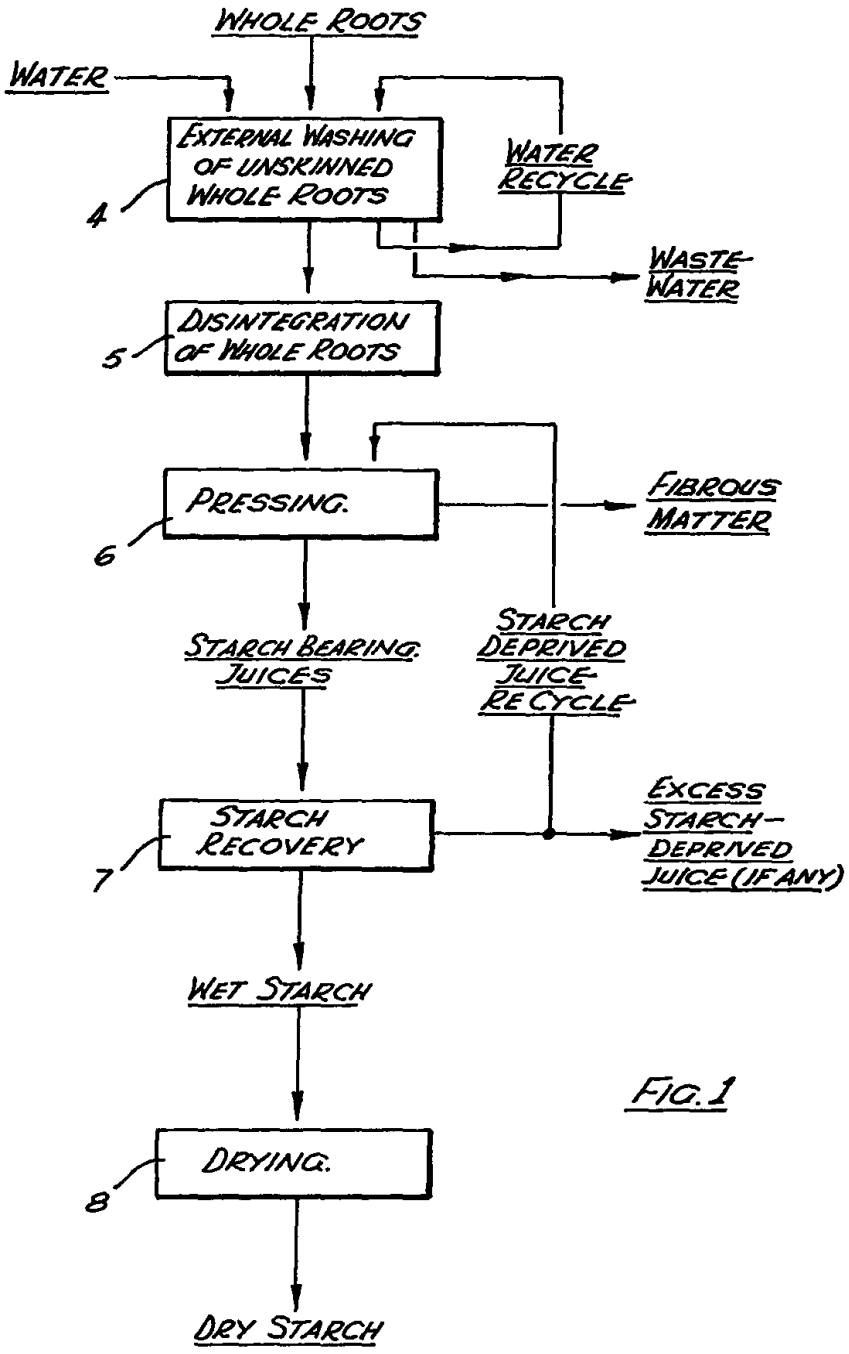
WHOLE ROOTS
WATER
EXTERNAL WASHING OF UNSKINNED WHOLE ROOTS
4
WATER RECYCLE
WASTE WATER
DISINTEGRATION OF WHOLE ROOTS
5
PRESSING.
6
FIBROUS MATTER
STARCH BEARING JUICES
STARCH DEPRIVED JUICE RECYCLE
STARCH RECOVERY
7
EXCESS STARCH-DEPRIVED JUICE (IF ANY)
WET STARCH
DRYING.
8
DRY STARCH

FIG. 1

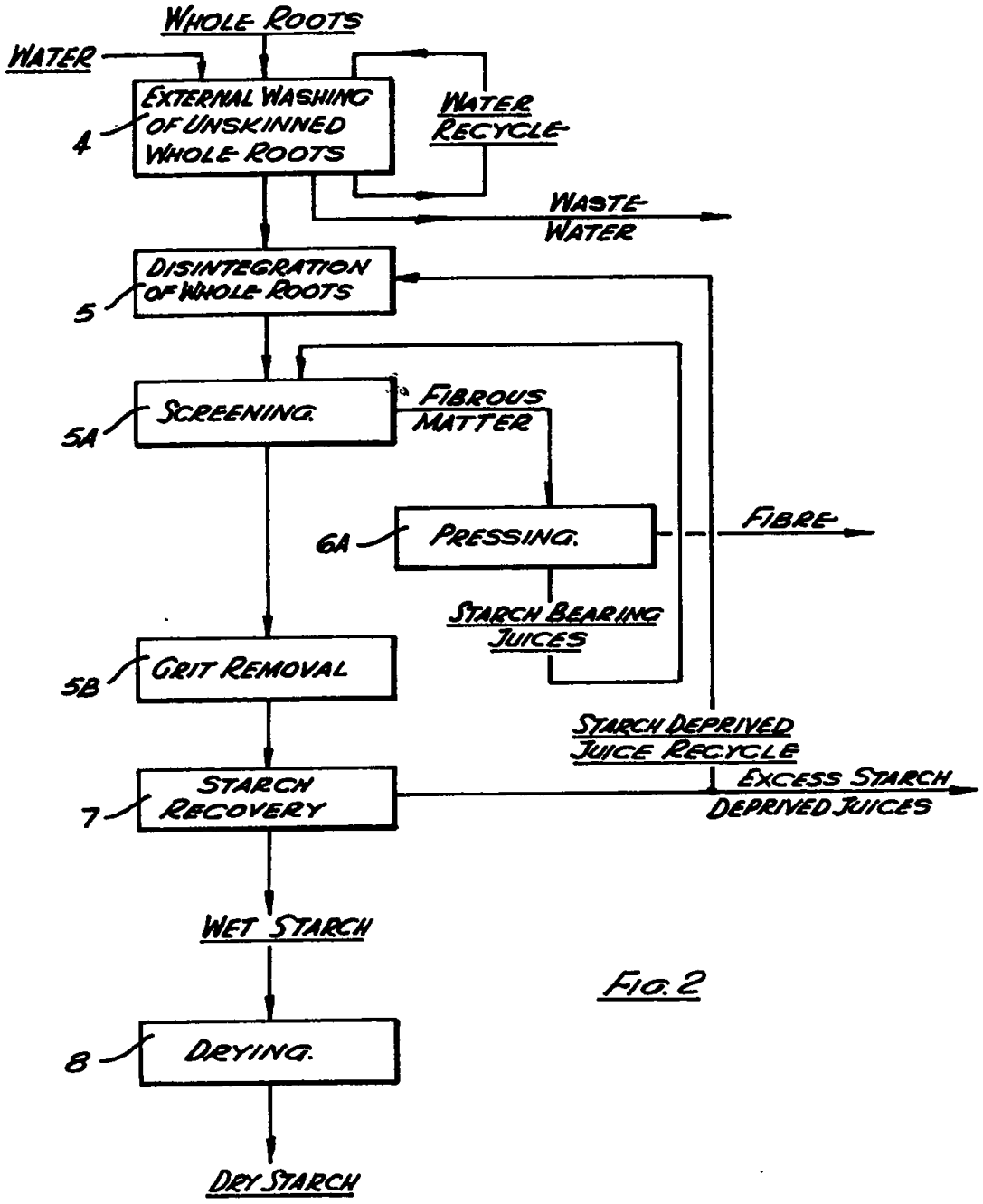
WHOLE ROOTS
WATER
EXTERNAL WASHING OF UNSKINNED WHOLE-ROOTS
4
WATER RECYCLE
WASTE-WATER
DISINTEGRATION OF WHOLE-ROOTS
5
SCREENING
5A
FIBROUS MATTER
PRESSING
6A
FIBRE
STARCH BEARING JUICES
GRIT REMOVAL
5B
STARCH DEPRIVED JUICE RECYCLE
STARCH RECOVERY
7
EXCESS STARCH DEPRIVED JUICES
WET STARCH
DRYING
8
DRY STARCH

FIG. 2

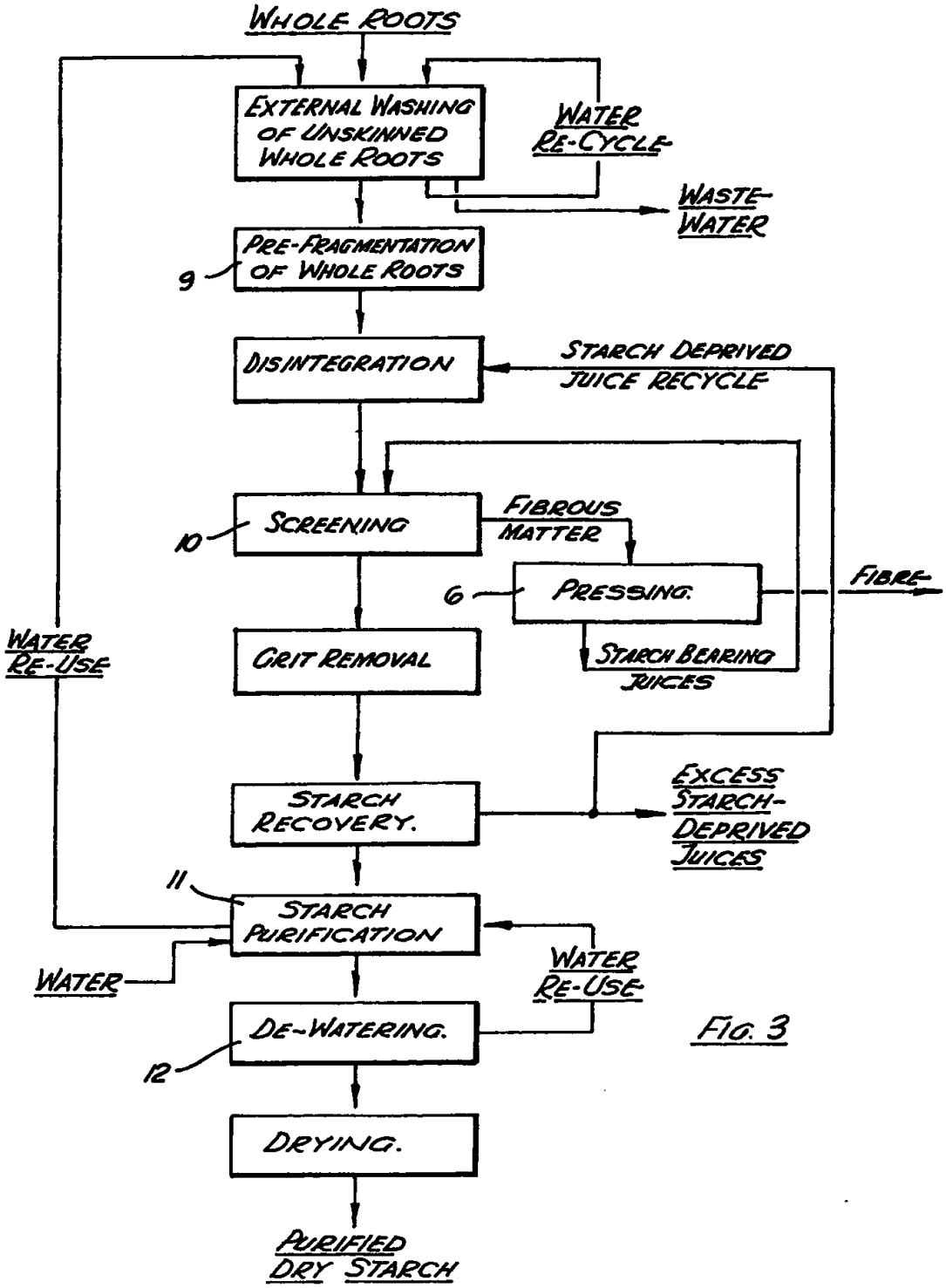
WHOLE ROOTS
EXTERNAL WASHING OF UNSKINNED WHOLE ROOTS
WATER RE-CYCLE
WASTE-WATER
9
PRE-FRAGMENTATION OF WHOLE ROOTS
DISINTEGRATION
STARCH DEPRIVED JUICE RECYCLE
10
SCREENING
FIBROUS MATTER
6
PRESSING.
FIBRE
WATER RE-USE
GRIT REMOVAL
STARCH BEARING JUICES
STARCH RECOVERY.
EXCESS STARCH-DEPRIVED JUICES
11
STARCH PURIFICATION
WATER
WATER RE-USE
DE-WATERING.
12
DRYING.
PURIFIED DRY STARCH

FIG. 3

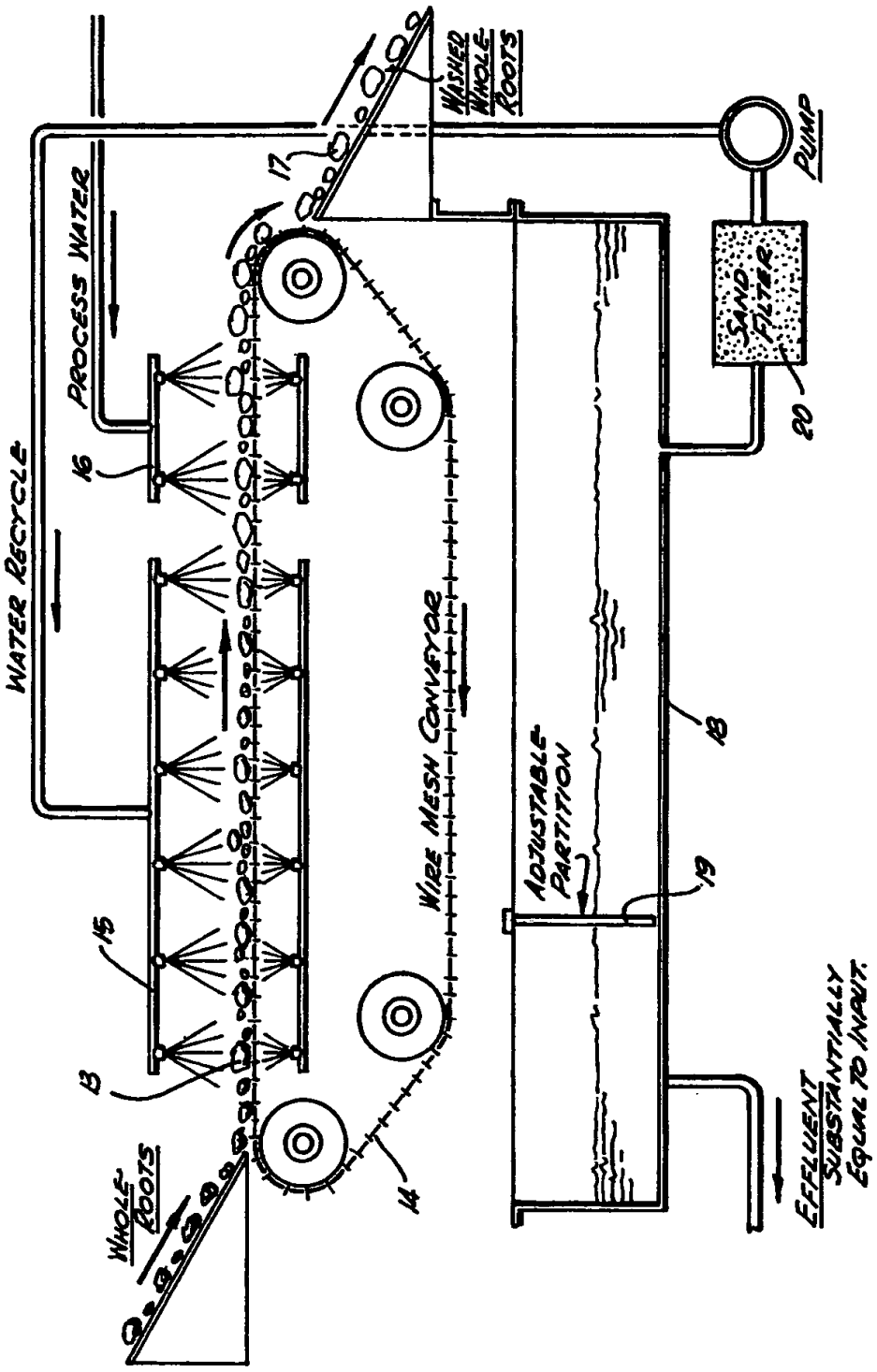
WASHED WHOLE ROOTS
PUMP
17
PROCESS WATER
SAND FILTER
20
16
WATER RECYCLE
WIRE MESH CONVEYOR
ADJUSTABLE PARTITION
18
19
15
13
14
WHOLE ROOTS
EFFLUENT SUBSTANTIALLY EQUAL TO INPUT.

FIG. 4

SPECIFICATION

Starch extraction

This invention relates to the extraction of starch from the roots of starch-bearing plants such as potatoes, cassava, yams, taro and the like.

The invention is applicable to starch-bearing vegetable products generally (referred to hereinafter simply as "roots") but is primarily concerned with starch extraction from cassava roots, and therefore will be described herein mainly in terms of a method primarily intended for use in that connection.

There are certain preliminary and final steps in the recovery of starch from cassava roots which are common to both the prior art and the present invention. The preliminary steps consist in collecting the roots, clearing them of woody parts such as stems, adherent stones and like unwanted matters, removing adherent dirt in a trommel (for example) and externally washing the roots. The final steps follow the actual starch recovery, and consist in purification of the recovered starch (if required) and drying it.

The prior art method of starch extraction, being those steps occurring between the preliminary and final steps mentioned above, comprise:

(a) peeling the roots by machine or by hand;

(b) shredding or other disintegration of the peeled roots, usually in a rasp machine, or a screen-type hammer mill, or other screen-type shredding machine;

(c) adding water to the root pulp to remove unwanted soluble materials from the starch-bearing remainder and to dilute that remainder in readiness for separation of fibrous matter from the starch-bearing liquor;

(d) screening or like treatment of the diluted remainder for separation of the fibrous matter and collection of the starch-bearing liquor;

(e) concentrating and de-gritting the liquor, for example in a series of hydrocyclones; and

(f) filtration of the concentrated liquor (preferably under vacuum) to isolate the starch.

This is followed by drying the starch in known manner. Drying of the starch may follow directly after the steps (a) to (f) if a commercial grade of starch is required, but if a superfine grade starch is required, drying may follow purification of the starch in known manner.

The prior starch recovery method, as outlined above is open to objection in several respects. The main objections are that the starch, even after final purification, is frequently discolored; and, the actual starch extraction method (as per steps (a) to (f) above) consumes a large amount of water.

We have concluded that the factors responsible for discoloration arise during performance of the steps lettered (b) to (d) above; that is, when the material under treatment is extensively water diluted. It would appear that the water creates an environment for the root materials conducive to the formation of protein tannin complexes which cause discoloration. This discoloration can be partly remedied by thick peeling of the roots (that is, peeling which removes as much as 12% by weight of the roots) as the agents (naturally present in the roots) responsible for the mentioned formation of discoloration complexes are found to be in highest concentration in and adjacent to the root skin. Another expedient intended to ameliorate discoloration is to include sulphur dioxide in the water. This cures discoloration up to a point, but adds to the pollutive nature of the effluent which is already pollutive on its own account and is also voluminous.

In referring to the expedients of thick peeling and/or addition of SO_2 it will be appreciated that one or both of these expedients does not amount to a cure for discoloration, since even when they are practiced, discoloration sufficient for rejection of a starch batch will still occur and even when they are beneficial in this respect it is frequently only to a degree such that a batch of starch is only sufficiently cured of discoloration as to enable that batch, although still discolored, just to escape rejection on that account.

When made by the method subject of the present invention, starch, whether it be of commercial or superior grade, is white.

With regard to water consumption, our experiments have shown that with cassava roots, containing a normal 65% natural moisture, the amount of water consumed to produce 1 ton of starch is:

(a) by the prior method outlined above – 55 m^3

(b) by the method subject of this invention – less than 10 m^3

Dis-coloration and water consumption are mentioned above as shortcomings of the prior art method of starch recovery. There are others. For example:

(a) The previous necessity to peel the roots, by hand or by machine is an expensive step in the treatment. If it is done by hand it is labour intensive; if by machine, the capital outlay is substantial. Whichever way it is done, it involves loss of a substantial proportion of starch-bearing root material.

(b) The previous use of rasp or screen-type root disintegrating machinery represents a substantial initial outlay, and sustained running expense since the rasps wear out rapidly and therefore have to be replaced frequently. This is expensive in itself and also with regard to further loss in shut-down time to enable rasp replacements to be made. Much the same kind of loss is involved in the use of screen-type disintegrators because the screens require frequent cleaning to clear them of fibrous matter and they are necessrily out of service during cleaning.

The object of this invention is to overcome the shortcomings referred to above in a very simple manner.

This is mainly achieved, so far as producing white starch is concerned, by ensuring that at no stage of starch extraction are conditions conducive to formation of the mentioned complexes allowed to prevail. In this connection it will be appreciated that in the natural condition of the roots the only moisture in the roots is the juices inherent to them, and although these inherent juices are present in the proportion of as much as 65% by weight of the roots they provide

an environment, internal to the root, in which precipitation or other formation of the complexes responsible for dis-coloration does not occur. Thus, by one aspect of the present invention no water is added to the roots undergoing starch extraction, and the only moisture used during that extraction consists of the mentioned natural or inherent juices.

Other advantages due to the present invention are:-

(a) water saving (as previously set forth);

(b) the entire roots can be effectively processed; that is without skin or peel removal;

(c) no SO_2 or other whitening agent is employed;

(d) such effluent as results from practicing the instant method is less pollutive than heretofore and is reduced in volume to such a degree as to be virtually neglible; and

(e) comminution or pulverisation of the roots is performed without need for rasping or use of screen-type mills.

The invention provides a method of recovering starch from starch-bearing roots comprising the steps of:

(a) pulverising the whole, unskinned, roots;

(b) pressing the solids ingredient of the pulverised whole roots to express and remove from the fibrous material of the roots the naturally present juice content together with the starch of the roots;

(c) separating the said fibrous material from the juice remaining therewith;

(d) separating starch from the resulting juice; and

(e) returning at least part of the resulting substantially starch-free juice to the roots during pulverisation thereof;

said steps (a) to (e) being performed in the absence of liquid other than said naturally present root juices.

Examples of the invention will now be described in terms of the drawings herewith.

Figure 1 is a flow sheet setting forth a simple way of performing the invention being one suited for the recovery of commercial grade starch.

Figure 2 is another flow sheet which largely repeats Figure 1 except for minor changes in juice re-cycling and inclusion of screening and grit removal steps.

Figure 3 is also a flow sheet, but one showing the steps of a preferred embodiment for the recovery of super refined starch.

Figure 4 is a diagrammatic representation of apparatus suitable for external washing of whole roots.

Referring to Figure 1, the whole roots after having been cleared of adherent stones and like excresent matters are subjected to external washing substantially in conventional manner. The woody stems or "setts" of the roots are preferably, but not necessarily, also removed. This washing may be a water wash with extensive water re-cycling as indicated at 4.

The washed whole roots are then finely disintegrated (5) in, for example, a shredder of the kind known as a "ripple" mill as manufactured by Californian Pellet Mills Limited. This results in more-or-less complete pulverisation of the whole roots except for much of the woody matters remaining in elongate fibrous condition.

The pulverised roots are then compressed (6). This can be carried out in a fibre press of any known design, preferably being one by which the moisture content of the fibre is reduced to below 75% by weight. The fibrous matter is residue for disposal in such manner as may be convenient.

Recovery of starch from the starch-bearing juices (7) is performed by conventional apparatus such as a decanter centrifuge and the juice output, or most of it, is sent back to the pressing stage 6 to assist in freeing the starch fo subsequent recovery. There will usually be more of this juice than there is need for in the pressing stage and the excess is drawn off for disposal in any convenient manner, or reserved for further use.

The wet starch can then be dried (8) for commercial grade, or it may be further refined if top grade starch is required.

The process of Figure 2 differs from that of Figure 1 mainly because the step of pressing is applied to fibrous matter removed from the pulverised whole roots as distinct from being applied directly to the whole roots themselves.

Referring to Figure 2 steps 4 and 5 are the same as in Figure 1 but are followed by screening (step 5A) to remove fibrous matter which is then subjected to pressing, step 6A, substantially as before. This pressing step 6A results in fibrous material to be discarded and starch bearing juices which may be restored to the main treatment line by re-admission just before the screening step 5A.

In some cases the presence of grit is a problem, and in such cases a conventional grit-removal step may be inserted as indicated at 5B.

From that stage the process may proceed as before except that for preference the juice recovered from step 7 is restored to the main line at step 5 as indicated.

The process illustrated by Figure 3 is, in essence, the same as that already described, in terms of Figure 2, except that it introduces:-

(a) a step (9) of coarse fragmentation of the whole roots as some forms of disintegration apparatus are not suited for acceptance of whole roots;

(b) water flooding for starch purification (11) and sends used water back for use in the washing stage, and

(c) de-watering (12) of the purified starch provides water for re-use in the purification.

All of the steps subject of the method hereof may be carried out by use of known apparatus, however, the washing step (4 in Figure 1) is preferably performed by use of apparatus (Figure 4) which we have devised specially for this step. Referring to that Figure, the whole roots 13 are fed into the top flight of a multi-holed conveyor 14 where they are preliminarily cleaned by re-cycle water sprayed from header 15, and finally cleaned by un-used water issuing from a second header 16.

Washed roots 17 proceed to disintegration, and the wash water with the removed dirt falls into a catchment vessel 18. Experiment has shown that most of the removed dirt enters vessel 18 near its

left-hand end (as shown in Figure 4) and is thus carried away as effluent. The amount of this effluent preferably does not exceed the amount of un-used water discharged by way of header 16.

Vessel 18 is preferably equipped with a partition 19 to deter the dirtier effluent water mingling with the cleaner water. The cleaner water is sent through a filter 20 and is pumped back to header 15 for re-use.

CLAIMS

1. A method of recovering starch from starch-bearing roots comprising the steps of:

(a) pulverising the whole, unskinned, roots;

(b) pressing the solids ingredient of the pulverised whole roots to express and remove from the fibrous material of the roots the naturally present juice content together with the starch of the roots;

(c) separating the said fibrous material from the juice remaining therewith;

(d) separating starch from the resulting juice; and

(e) returning at least part of the resulting substantially starch-free juice to the roots during pulverisation thereof;

said steps (a) to (e) being performed in the absence of liquid other than said naturally present root juices.

2. A method according to claim 1 wherein following said step (a) the pulverised roots are screened to separate fibrous matter therefrom, the separated fibrous matter is then pressed for recovery of juices therefrom and the juice so recovered is returned to the pulverised roots being screened.

3 .A method according to claim 1 or claim 2 wherein the starch recovered following performance of step (e) is purified by use of water and the used water is then used as root cleaning water prior to performance of step (a).

4. A method according to claim 3 wherein purification of starch is followed by de-watering and the resulting water is used for further starch purification.

5. A method according to claim 3 or claim 4, wherein at least some of the used root cleaning water is re-used as further cleaning water.

6. A method of starch extraction substantially as herein described with reference to Figure 1, Figure 2 or Figure 3 of the drawings herewith.

7. Root washing apparatus when used in performance of a method according to claim 5 or claim 6 and substantially as herein described with reference to Figure 4 of the drawings herewith.

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